Having thus described the aforementioned invention,

We Claim:

1. A scintillation detector array for encoding energy, position and time coordinates of gamma ray interactions for use in Positron Emission Tomography imaging, said scintillation detector array comprising:

a plurality of discrete scintillator elements which interact with incident gamma-rays to produce a quantifiable number of scintillation photons, wherein each of said plurality of discrete scintillators is composed of a first layer having a first selected decay time and a second layer having a second selected decay time, wherein said first selected decay time is not equal to said second selected decay time, and further wherein said first layer is composed of a first selected scintillator material and said second layer is composed of a second selected scintillator material and wherein said first and second selected scintillator materials are stacked one upon the other, whereby a pulse shape discrimination technique is used to determine which said layer the gamma ray interacts;

an optical detector associated with each of said plurality of discrete scintillator elements and positioned for sensing and quantifying said scintillation photons exiting each of said plurality of discrete scintillator elements;

a continuous light guide having first and second planar surfaces disposed between said plurality of discrete scintillator elements and said associated optical detectors for distributing scintillation photons exiting said plurality of discrete scintillators to said associated optical detectors; and

a means operatively associated with said scintillation detector array for determining time, energy, depth and transverse and longitudinal position coordinates of gamma ray interactions in said plurality of discrete scintillator elements.

2. The scintillator detector array of claim 1 wherein said first and said second layers are composed of High-Z scintillator materials.

3. The scintillation detector array of Claim 1 wherein said plurality of discrete scintillator elements, which interact with incident gamma-rays to produce a quantifiable number of scintillation photons, is arranged in an (m) x (n) array, and said plurality of optical detectors is arranged in an (q) x (p) array, wherein said plurality of optical detectors is for sensing and quantifying said scintillation photons exiting each of said plurality of discrete scintillator elements.

4. The scintillator detector array of claim 3 wherein said (m) x (n) array equals said (q) x (p) array.

5. The scintillator detector array of claim 3 wherein said (m) x (n) array does not equal said (q) x (p) array.

6. The scintillator detector array of claim 2 wherein said first and said second layer of each of said plurality of discrete scintillator elements is composed of LSO.

7. The scintillator detector array of claim 2 wherein said High-Z scintillator material is selected from a group consisting of LSO, LYSO, LGSO, GSO, LuAP, and YAP.

8. The scintillator detector array of claim 2 wherein said first layer is composed of a first selected scintillator material and said second layer is composed of a second selected scintillator material.

9. The scintillator detector array of claim 8 wherein said first selected scintillator material and said second selected scintillator material are selected for use in techniques for separating low and high energies.

10. The scintillator detector array of claim 8 wherein said first selected scintillator material and said second selected scintillator material are selected for use in techniques for determining depth of interaction of the gamma rays with said plurality of discrete scintillator elements.

11. The scintillator detector array of claim 8 wherein said first selected scintillator material and said second selected scintillator material are selected for use in techniques for distinguishing pulse heights of gamma ray interactions.

12. The scintillator detector array of claim 1 wherein said first selected scintillator material is YSO and said second selected scintillator material is a High-Z scintillator material.

13. The scintillator detector array of claim 1 wherein said first selected scintillator material is LSO and said second selected scintillator material is GSO.

14. The scintillator detector array of claim 1 wherein said first selected scintillator material is YSO and said second selected scintillation material is LSO.

15. The scintillator detector array of claim 1 wherein said light guide is active.

16. The scintillation detector array of Claim 1 wherein said light guide is non-active.

17. A scintillation detector array for encoding energy, position and time coordinates of gamma ray interactions for use in Positron Emission Tomography imaging, said scintillation detector array comprising:

a plurality of discrete scintillator elements which interact with incident gamma-rays to produce a quantifiable number of scintillation photons, wherein each of said plurality of discrete scintillators is composed of a first layer having a first selected decay time and a second layer having a second selected decay time, wherein said first selected decay time is not equal to said second selected decay time, and further wherein said first and said second layers are composed of High-Z scintillator materials, and further wherein said first layer is composed of a first selected scintillator material and said second layer is composed of a second selected scintillator material and wherein said first and second selected scintillator materials are stacked one upon the other, whereby a pulse shape discrimination technique is used to determine which said layer the gamma ray interacts;

an optical detector associated with each of said plurality of discrete scintillator elements and positioned for sensing and quantifying said scintillation photons exiting each of said plurality of discrete scintillator elements;

a continuous light guide having first and second planar surfaces disposed between said plurality of discrete scintillator elements and said associated optical detectors for distributing scintillation photons exiting said plurality of discrete scintillators to said associated optical detectors; and

a means operatively associated with said scintillation detector array for determining time, energy, depth and transverse and longitudinal position coordinates of gamma ray interactions in said plurality of discrete scintillator elements.

18. The scintillation detector array of Claim 17 wherein said plurality of discrete scintillator elements, which interact with incident gamma-rays to produce a quantifiable number of scintillation photons, is arranged in an (m) x (n) array, and said plurality of optical detectors is arranged in an (q) x (p) array, wherein said plurality of optical detectors is for sensing and quantifying said scintillation photons exiting each of said plurality of discrete scintillator elements.

19. The scintillator detector array of claim 18 wherein said (m) x (n) array equals said (q) x (p) array.

20. The scintillator detector array of claim 18 wherein said (m) x (n) array does not equal said (q) x (p) array.

21. The scintillator detector array of claim 17 wherein said light guide is active.

22. The scintillation detector array of Claim 17 wherein said light guide is non-active.

23. A scintillation detector array for encoding energy, position and time coordinates of gamma ray interactions for use in Positron Emission Tomography imaging, said scintillation detector array comprising:

a plurality of discrete scintillator elements which interact with incident gamma-rays to produce a quantifiable number of scintillation photons, wherein each of said plurality of discrete scintillators is composed of a first layer having a first selected decay time and a second layer having a second selected decay time, wherein said first selected decay time is not equal to said second selected decay time, and further wherein said first and said second layers are composed of High-Z scintillator materials, and further wherein said first layer is composed of a first selected scintillator material and said second layer is composed of a second selected scintillator material and wherein said first and second selected scintillator materials are stacked one upon the other, whereby a pulse shape discrimination technique is used to determine which said layer the gamma ray interacts;

an optical detector associated with each of said plurality of discrete scintillator elements and positioned for sensing and quantifying said scintillation photons exiting each of said plurality of discrete scintillator elements;

a continuous light guide having first and second planar surfaces optically bonded to said plurality of discrete scintillator elements, whereby said plurality of discrete scintillator elements is disposed between said light guide and said optical detectors, wherein said plurality of discrete scintillator elements distribute scintillation photons exiting said plurality of discrete scintillators to said associated optical detectors; and

a means operatively associated with said scintillation detector array for determining time, energy, depth and transverse and longitudinal position coordinates of gamma ray interactions in said plurality of discrete scintillator elements.

24. The scintillation detector array of Claim 23 wherein said plurality of discrete scintillator elements, which interact with incident gamma-rays to produce a quantifiable number of scintillation photons, is arranged in an (m) x (n) array, and said plurality of optical detectors is arranged in an (q) x (p) array, wherein said plurality of optical detectors is for sensing and quantifying said scintillation photons exiting each of said plurality of discrete scintillator elements.

25. The scintillator detector array of claim 24 wherein said (m) x (n) array equals said (q) x (p) array.

26. The scintillator detector array of claim 24 wherein said (m) x (n) array does not equal said (q) x (p) array.

27. The scintillator detector array of claim 23 wherein said first and said second layer of each of said plurality of discrete scintillator elements is composed of LSO.

28. The scintillator detector array of claim 23 wherein said High-Z scintillator material is selected from a group consisting of LSO, LYSO, LGSO, GSO, LuAP, and YAP.

29. The scintillator detector array of claim 23 wherein said first layer is composed of a first selected scintillator material and said second layer is composed of a second selected scintillator material.

30. The scintillator detector array of claim 29 wherein said first selected scintillator material and said second selected scintillator material are selected for use in techniques for separating low and high energies.

31. The scintillator detector array of claim 29 wherein said first selected scintillator material and said second selected scintillator material are selected for use in techniques for determining depth of interaction of the gamma rays with said plurality of discrete scintillator elements.

32. The scintillator detector array of claim 29 wherein said first selected scintillator material and said second selected scintillator material are selected for use in techniques for distinguishing pulse heights of gamma ray interactions.

33. The scintillator detector array of claim 29 wherein said first selected scintillator material is YSO and said second selected scintillator material is a High-Z scintillator material.

34. The scintillator detector array of claim 29 wherein said first selected scintillator material is LSO and said second selected scintillator material is GSO.

35. The scintillator detector array of claim 29 wherein said first selected scintillator material is YSO and said second selected scintillation material is LSO.

36. The scintillator detector array of claim 23 wherein said light guide is active.

37. The scintillation detector array of Claim 23 wherein said light guide is non-active.

38. A scintillation detector array for encoding energy, position and time coordinates of gamma ray interactions for use in Positron Emission Tomography imaging, said scintillation detector array comprising:

a plurality of discrete scintillator elements which interact with incident gamma rays to produce a quantifiable number of scintillation photons, wherein each of said plurality of discrete scintillators is composed of a first layer having a first selected decay time and a second layer having a second selected decay time, wherein said first selected decay time is not equal to said second selected decay time, and further wherein said first layer is composed of a first selected scintillator material and said second layer is composed of a second selected scintillator material and wherein said first and second selected scintillator materials are stacked one upon the other, whereby a pulse shape discrimination technique is used to determine which said layer the gamma ray interacts;

an optical detector associated with each of said plurality of discrete scintillator elements and positioned for sensing and quantifying said scintillation photons exiting each of said plurality of discrete scintillator elements wherein said plurality of discrete scintillator elements, which interact with incident gamma rays to produce a quantifiable number of scintillation photons, is arranged in an (m) x (n) array, and said plurality of optical detectors is arranged in an (q) x (p) array, wherein said (m) x (n) array does not equal said (q) x (p) array and further wherein said plurality of optical detectors is for sensing and quantifying said scintillation photons exiting each of said plurality of discrete scintillator elements;

a continuous light guide having first and second planar surfaces disposed between said plurality of discrete scintillator elements and said associated optical detectors for distributing scintillation photons exiting said plurality of discrete scintillators to said associated optical detectors; and

a means operatively associated with said scintillation detector array for determining time, energy, depth and transverse and longitudinal position coordinates of gamma ray interactions in said plurality of discrete scintillator elements.

39. The scintillator detector array of claim 38 wherein said first and said second layers are composed of High Z scintillator materials.

40. The scintillator detector array of claim 39 wherein said first and said second layer of each of said plurality of discrete scintillator elements is composed of LSO.

41. The scintillator detector array of claim 39 wherein said High-Z scintillator material is selected from a group consisting of LSO, LYSO, LGSO, GSO, LuAP, and YAP.

42. The scintillator detector array of claim 39 wherein said first layer is composed of a first selected scintillator material and said second layer is composed of a second selected scintillator material.

43. The scintillator detector array of claim 42 wherein said first selected scintillator material and said second selected scintillator material are selected for use in techniques for separating low and high energies.

44. The scintillator detector array of claim 42 wherein said first selected scintillator material and said second selected scintillator material are selected for use in techniques for determining depth of interaction of the gamma rays with said plurality of discrete scintillator elements.

45. The scintillator detector array of claim 42 wherein said first selected scintillator material and said second selected scintillator material are selected for use in techniques for distinguishing pulse heights of gamma ray interactions.

46. The scintillator detector array of claim 38 wherein said first selected scintillator material is YSO and said second selected scintillator material is a High Z scintillator material.

47. The scintillator detector array of claim 38 wherein said first selected scintillator material is LSO and said second selected scintillator material is GSO.

48. The scintillator detector array of claim 38 wherein said first selected scintillator material is YSO and said second selected scintillation material is LSO.

49. The scintillator detector array of claim 38 wherein said light guide is active.

50. The scintillation detector array of Claim 38 wherein said light guide is non-active.